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ABSTRACT

Robert Gagne's theories and research have had a significant impact on practitioners in general, especially instructional designers. He has influenced teaching and curriculum development and used standard practices as a stimulus for the development of theory. This paper explores Gagne's influence on practice by examining the relationship between theory and practice, especially in relation to instructional design, and then discussing curriculum development and transfer of learning. Gagne wanted to apply theory to practice, and was especially interested in applying theory to teaching and learning to make it more effective and efficient. This paper includes discussions of the literature on Gagne which covers the practical use of his cumulative learning theory, his notion of the learning hierarchy in educational curriculums, and the importance of learner outcomes when analyzing content of instructional design literature and practice. The influence of Gagne's theories on instructional design practice spans a gap from a reliance on behaviorism as a foundational theory to the eventual adoption of cognitivism as an underlying theory. Gagne's theories and research have been applied to a wide variety of content areas, age levels, and learning environments. (Contains 50 references.) (Author/SWC)

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Title:

The Impact of Gagne's Theories on Practice

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Robert Gagne's theories and research in instruction and learning have been discussed in other chapters, where their relationships to each other are explored in depth. Gagne's theories and research have had significant impact on practitioners in general and of instructional designers in specific, and this will be the focus of this paper. Given the length of his professional career, and the esteem with which his numerous publications are held, it is axiomatic that he has had an impact. Further examination reveals that he also has influenced teaching and curriculum development through his research and theory. He also used standard practices as a stimulus for the development of theory. Throughout his career, Gagne was always cognizant of the gap between theory and practice, and addressed this gap by directing his investigations toward practical problems.

I personally have felt the impact of Robert Gagne during my military training in the late 1950s and early 1960s. These were my earliest experiences as an adult learner and a teacher of adults. Reviewing the Gagne literature for this paper confirmed a suspicion I've had since these military experiences. There seems not only to be a possibility, but also a high probability, that my training was influenced in no small measure by Gagne and his associates in the military. I experienced first hand the effectiveness of military training based upon Gagne's principles as both a trainer and trainee. However, my interest in Gagne's influence on practice is more than an outgrowth of my military experience. That, in conjunction with 25 years as a practicing instructional designer in public schools, colleges and industry has created a somewhat personal relationship to Gagne and his contributions.

This paper will explore Gagne's influence on practice by first examining the relationship between theory and practice especially in relation to instructional design, and then discussing curriculum development and transfer of learning.

The Relationship between Theory and Practice

Gagne typically examined the interaction and dependencies between theory and practice. This is noteworthy given the attention that the application of theory to practice has also received by other researchers. The work of Huberman (1990), London (1973), Battersby (1987), Clark (1988), Schön (1987), and Willis (1993), are but a few examples of researchers who have joined the ranks of researchers who argue that good theory should be applied to practice, and conversely exemplary practice should be examined as a basis for new theory development. Huberman (1990) goes further in linking theory to practice by suggesting that researchers should start their research by first contacting practitioners. Furthermore, he notes that ". . . research findings can flow into practitioner settings and craft knowledge can move into research settings as a natural function of the ongoing relationships between both parties feeding more or less automatically into their customary transactions" (p. 387). This kind of relationship, although described by Huberman in 1990, seems to reflect many situations described by Gagne in his early work. For example, Gagne (1962), in his article "Military Training and Principles of Learning" discusses the differences between those learning principles studied in laboratories and their application to military training, and recognizes the difficulties of applying theory to practice.

> I am not asking, how can a scientific approach be applied to the study of training? Nor am I asking how can experimental methodology be applied to the study of training? The question is, rather, how can what you know about learning as an event, or as a process be put to use in designing training so that it will be maximally effective? (p. 84)

Gagne, as early as the late 1950s and early 1960s, had clearly established an interest in and desire to apply theory to practice. He was especially interested in examining the larger issue of applying theory to training, teaching, and learning with the eventual objective of making it more effective and efficient.

Gagne's early observations in military training, research, and academic laboratories provided ample evidence of the inadequacy of existing learning theories and principles as vehicles for solving pressing training problems, and the impact of his reactions to these observations was profound. For example, his theory and research findings were applied to the development of training on trouble shooting aircraft electrical systems and electronics. This is one specific area in which I experienced training bearing the earmark of Gagne's theories. The trouble shooting training I participated in (and later taught) was carefully sequenced hierarchically, and component tasks were intended as mediators that directed the instruction and learning process toward the ultimate objective. Military trainees were evaluated for mastery of prerequisite skills and taught or retaught these skills where necessary. All of these strategies reflect the influence of Robert Gagne.

Gagne's ever present concern with practice, even in the midst of theory development, continues to benefit education and training. These benefits will be explored here, especially in terms of curriculum development, instructional design practice and transfer of training.

Impact of Gagne's Theories on Curriculum Development Practice

An examination of curriculum and curriculum development logically begins with a concept definition. Gagne (1966) defines curriculum as

> . . . a sequence of content units arranged in such a way that the learning of each unit may be accomplished as a single act, provided the capabilities described by specified prior units (in the sequence) have already been mastered by the learner. (p. 22)

This orientation is a logical extension of his cumulative learning theory and his notion of the learning hierarchy.

Contrasting definitions illustrate the diversity of thinking in this area. For example, Bloom (1976) views curriculum as occurring in two forms--visible and invisible. The former being the school subjects one is taught, and the latter being those lessons which teach one his or her place in the world. Gagne's concept is closer to the first view.

Further contrasting definitions are offered by Bruner (1966)[2], Eisner (1985)[3], and Klein (American Society for Curriculum Development, 1993)[4]. Bruner and Klein provide views that are more traditional and closer to that of Gagne. Eisner, on the other hand, also recognizes the existence of both formal and informal curricula, similar to Bloom. While not all theorists agree on the definition of curriculum, Gagne's position has been used as the basis for a number of important efforts in schools and training.

School program design. The most pervasive example of an application of Gagne's theories and research to a large scale curriculum project is *Science: A Process Approach* (SAPA), which is part of the American Association for the Advancement of Science (AAAS) Commission on Science Education. These science curriculum materials were influential in schools and colleges during the 1960s and early 1970s and represent a significantly large scale curriculum effort utilizing Gagne's theories and research in the areas of problem solving and scientific inquiry. Gagne's view of a process approach to science is scientific inquiry and is based on students having a large knowledge base which they subsequently utilize to make and then test inductive inferences. The underlying foundation for the process approach is hierarchical, and presumes that learners have the prerequisite process skills as background. Gagne (1965) maintained that

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[2]Bruner's (1966) definition is "A curriculum should involve the mastery of skills that in turn lead to the mastery of still more powerful ones, the establishment of self-reward sequences.
. . . a curriculum should be prepared jointly by the subject matter expert, the teacher, and the psychologist with due regard for the inherent structure of the material, its sequencing, the psychological pacing of reinforcement and the building and maintaining of predispositions to problem solving (pp. 35, 70).

[3]Eisner (1985) defines three curriculums: null, implicit and explicit.
Null: A curriculum in which all of those things not taught and not learned in schools--there simply are no opportunities to learn them.
Implicit: (This is similar to Bloom's latent curriculum). A curriculum in which ideas, values, attitudes, and processes are not explicitly taught; but they are none-the-less, learned. They are learned through the subtleties of teacher values and attitudes, as well as the signals sent by the organization as a whole (e.g., where it puts its resources, and what it values--sports, academics, fine arts, etc.)
Explicit: The curriculum to which students, teachers and administrators must attend to most in schools. It is what parents and society expect students to have learned, and what they try and measure as predictors of success. This curriculum offers tangible evidence of its existence through instructional materials, technology, instructional strategies, guides, etc. The explicit curriculum is often perceived as that cumulative knowledge of human kind which is passed on through the generations.

[4]Klein's (American Society for Curriculum Development, 1993) definition is "Curriculum is those activities, processes and structural arrangements as intended for, employed in, or experienced in the school and classroom for the purposes of fulfilling the educative function (p. 2.16).

the process approach is a middle ground between the "content approach" and the "creative approach" and "It substitutes the notion of having children learn generalizable process skills which are behavioral specific, but which carry the promise of broad transferability across many subject matters" (p. 4). It can also be said that SPAP and its orientation to teaching elementary science and scientific inquiry, although first published in the sixties, remained immensely influential in science texts and other commercially published science materials well into the 1980s. Andrew Ahlgren of AAAS, co-author of *Science for All Americans*, provided further testimony to Gagne's influence on science curriculum, as well as his indirect influence on mathematics, and technology curriculum in specific (A. Ahlgren, October 3, 1994, personal communication). He stated that SAPA most certainly had tremendous influence on not only science, but also technology curriculum.

Not all see Gagne's influence on science curriculum as positive. Finiley (1983), for example, argues that Gagne's theories, as well as others of like mind, have propelled science curriculum in the wrong direction by advocating a commitment to inductive empiricism.[5] He maintains that a presentation of papers by Gagne to AAAS ". . . has had a substantial influence on curriculum, instruction, and research in science education since that presentation" (p. 47). Finiley then selects Gagne, in view of all others writing about science process, as the most influential when he says: "Although many science educators have written about science processes, the view established by Gagne has been most influential" (p. 48). He continues his argument from a philosophical perspective indicating that Gagne, similar to his predecessors like Francis Bacon, Robert Boyle, Sir Isaac Newton and Hume, embrace the positions of empiricism and induction. Finiley, although in fundamental disagreement with Gagne's approach to teaching science, substantiates the

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[5]Finiley, when discussing Gagne's theories is making direct reference to Gagne's influence on science curriculum through AAAS in general and SPAP in specific. The influence, as mentioned earlier, is centered around Gagne's perspective of a process approach where learners are taught to think and solve problems like a scientist would. In Gagne's (1965) scheme this would be accomplished b[5]Bruner's (1966) definition is "A curriculum should involve the mastery of skills that in turn lead to the mastery of still more powerful ones, the establishment of self-reward sequences.
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overreaching influence Gagne has had on the development of science through SAPA during the late 1960s and into the 1980s.

Hackett (1971) provides another example of the use of Gagne's theories on a large scale curriculum project in a public school setting. Although her work was primarily directed toward reading and communication skills curricula, she provides ample evidence of the application of Gagne's theories to social studies and mathematics as well. Hackett's experiments and curriculum projects focused on a performance-based approach which has many similarities to the outcome based education movement of the late 1980s and early 1990s.

There are also many examples of smaller scale curriculum efforts that apply Gagne's theory to curriculum development projects. Two examples are Gilbert's (1992) use of Gagne's hierarchies in his curriculum on questioning and taxonomies, and Lines's (1988) work with advanced economics. These programs provide evidence of more recent applications of Gagne's theories to curriculum. One can also examine as evidence Margaret E. Bell's (1982) article in which she makes a persuasive case for the application of Gagne's theories to designing programs. She argues that curriculum design and development has not been as systematic as the efforts of designing instruction. Bell recommends that Gagne's five capabilities can be applied to course instruction as well as program or curriculum development. John Flynn's (1992) also adapts Gagne's Events of Instruction to the very high profile and contemporary research area of cooperative learning.

School lesson design. When relating Gagne's theories to curriculum efforts that are directed toward individual lessons many of the examples utilize computer technology. Lesgold's (1987) effort wherein goal knowledge was examined as to its significance to ". . . intelligent machine . . . [and] human activity . . ." is an example of adapting Gagne's theories to curriculum and prerequisite skills in a novel way. Also in this category is the Smaldino and Thompson (1990) research relating the Events of Instruction to science education and computer technology. These authors propose designing science lessons focusing on the "Nine Events of Instruction" (p. 17). Jonassen (1988) has utilized many of Gagne's writings, theories and principles in the design of microcomputer courseware. He especially utilizes Gagne's Events of Instruction and his work in the area of hierarchies and prerequisite skills. Jonassen (1988) also utilizes Gagne's work with respect to learning outcomes in designing individual lessons to be delivered by computer courseware.

Training curriculum design. Gagne's theories also have been used extensively in training curriculum design in the private sector of business, or the non-school sector of governmental agencies. It is most appropriate to start with the military and defense related environments where the evidence of Gagne's influence abounds. While many of Gagne's early writings are generously sprinkled with references to military applications and research results conducted in military settings, there are also many current applications made in private sector training. Stepich (1991) and Garavaglia (1993) provide two examples. Stephich (1991) examines the idea of utilizing training to move learners from novice to expert status, and proposes a way to apply Gagne's "conditions of learning" to training design. Garavaglia (1993) suggests that designers take another look at the design phase of Instructional Systems Development (ISD). Garavaglia contends that: "For each event of instruction you should determine the method for which it can be achieved and the media necessary to achieve it" (p. 28). He continues by expanding on how the Events of Instruction can be used in conjunction with Kellers ARCS model in what Garavaglia's calls a technical training submethodology. Both of these articles utilize Gagne's theories to develop techniques, methods or practices and each imply that the practice based upon his theories has implications for a larger curriculum effort throughout a training program in the private sector.

Impact of Gagne's Instructional Design Theories on Instructional Design Practice

The profound influence of Gagne's theories on instructional design practice is most easily understood when positioning them into the context of his early theories of instruction or learning.[6] It is important to realize that he was

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[6]The influence of Gagne's theories on instructional design practice reveals two paths which are not only interrelated, but nearly inseparable. The first path is an analysis of textbooks and handbooks. The instructional design textbooks and handbooks serve many purposes, one of which is to provide a communication link between theory, research and the practice of instructional design in education, educational psychology and training. The argument here is that there are two important goals for texts and handbooks. First, to communicate to the readers' the theories and models found within them; and second, to promote these theories in the respective practices of education and training of their readers.

The second path is an examination of the practical research reports, journal articles and curriculum projects which report the findings of research, theory development and application to instructional design practice. These resources are more likely to be, in relation to this paper, reports on the application of Gagne's instructional design theories to specific content

one of the theorists instrumental in bridging the gap between the behaviorists of the 1950s and 1960s and the cognitivists of the 1970s and 1980s. Case and Berither (1984) maintain that when Gagne ". . . shifted the focus of attention from the *how* to the *what* of behavior change; that is, he shifted the focus from reinforcement to the nature of the behaviours themselves" (p. 144).

Case and Bereither (1984), suggest that Gagne not only moved away from reinforcement, but he also recognized learning as a more complex process than previously thought, and they elaborate on Gagne's recognition that learning was not confined to ". . . the learning of physical behaviors and simple stimulus-response connections but also the learning of concepts, rules, principles, intellectual skills and cognitive strategies" (p. 144). Using Gagne's earlier work as background, they suggest that the third and most important part of his work, which catapulted him beyond the behaviorists of that time, was his concept of sequencing intellectual skills and allowing the instruction to move systematically toward higher-order skills all while building on prerequisite skills.

Gagne had a part in the paradigm shift from behavioral to cognitive psychology in the early 1960s, and this brought about a predictable change in both instructional design literature and practice. The literature of the field, viewed as a communication link or mediator between theory and practice, is certainly a measure of just how pronounced his influence has been.[7]

Richey (1986) maintains that Gagne has had tremendous influence on instructional design practice through his theories, models and procedures for developing instruction. Instructional designers have embraced Gagne's theories for many reasons; however, one of the most compelling reasons lies in his work with learning outcomes. Gagne (1988) directs the instructional designer to utilize the following learner outcomes when analyzing content: intellectual skills, verbal information, cognitive strategies, motor-skills and attitudes. Subsequent to determining the desired learning outcome, the instructional designer is advised to complete the content analysis based on the expectations for the learner. The documentation of the design process where the designer selects the appropriate learner outcomes, completes the content analysis and develops the appropriate flow diagrams and procedures becomes the core of the instructional design document used to guide the instructional design project to completion.

No examination of Gagne's influence on practice would be complete without examining the influence of his theories on teacher education and ultimately on teachers, professors and the entire education enterprise. Furthermore, this examination compels the researcher to delve further into the definition and concepts of influence and change. Short term

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areas or disciplines within the educational or training arena. Since the author devoted considerable space and cited several sources from this path when examining Gagne's influence on curriculum, no further effort will be made to elaborate on these items. It is clear however, that Gagne's impact on instructional design practice is evident in the enormous number of journal articles, research reports and curriculum projects which refer to his work. The reader is well advised to pursue these resources or to refer to the curriculum section of this paper for further information. No specific effort has been made to identify when resources from one or another path are being highlighted other than to identify items as books, reports or journal articles.

[7]Textbooks and handbooks are a primary communication link between theory and practice, and as such they are an essential resource for measuring Gagne's influence. Among his texts are the following: the four editions of Gagne's The Conditions of Learning (1965), the two editions of Gagne and Briggs (1974 & 1979), Principles of Instructional Design and the third edition of the same title by Gagne, Briggs and Wager (1988). These books alone would indicate a monumental impact on instructional design practice since they are cited throughout the instructional design literature that parallels them, and almost all the instructional design literature that follows. They are also texts from which many instructional design practitioners in the 1970s and 1980s learned the theory and practice of instructional design.

There are several series of texts which further explain and apply Gagne's theories for practitioners. An example of a multiple series of texts is Dick and Carey's (1978, 1985, 1990), The Systematic Design of Instruction, with a fourth edition in press. There are very few practitioners anywhere haven't taken a course where this text was used, applied it to their practice, taught from it, or at least read it in part. Although the Dick and Carey editions can be characterized many ways, they are theoretically "vintage systems theory" with the strong influence of Gagne in their application of instructional design theory to practice. They also model Gagne's desire to be practical by presenting their system for designing instruction as one that accommodates either a "knowledge" or "product" approach. They add that they favor the product approach since it requires students to actually develop instruction as opposed to learning about instructional design as a theoretical concept. There are many other series and single texts which have been influenced by Gagne's theories and research, and one worthwhile consulting to this end.

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change in attitudes brought about in pre-service educators being exposed to Gagne's theories in methods and media/technology courses may be assessed traditionally in course evaluations and tests; however, expecting them to incorporate these theories and concepts into their teaching practice is a different matter. This is especially true when considered from the perspective of initiating permanent change on professionals who ultimately spend their careers in an organizational culture which has many years of history, precedence, and accepted methodology, which often reinforces the attitudes of experienced teachers, and shapes the attitudes of new teachers. Martin and Clemente (1990) argue that instructional systems design (ISD) has had minimum impact on schools because professionals as well as professors of ISD haven't considered carefully enough their clients (teachers) and the culture of schools. They further argue that until we (ISD professionals) understand that the accepting of the ISD approach would be considered an innovation in schools; therefore, subject to all the usual barriers to accepting change in the culture or social setting we will be unsuccessful in promoting ISD in schools.

Are we to conclude then that Gagne's theories have had little or no influence on teachers, professors and subsequently education:? Not necessarily! While it is true that there has not been a preponderance of teachers or educational systems adopting ISD in its entirety, there is evidence that teachers adapt ISD theories to their practice. In so far as Gagne's influence is concerned these adaptations are frequently made to ISD theories that often have his instructional theories embedded within them. A persuasive argument can be made that in implicit and often small ways, over an extended time period, teachers and professors exposed to ISD theories, models and procedures adapt them to their practice rather than adopt them. These adaptations bear resemblance to both Gagne and general systems theory. Planning proceeds from problem identification writing objectives and flow charting to sequencing content and concepts from simple to complex forming the basis for using lower level intellectual skills as a foundation for higher order skills, culminating with assessment. Given that this argument is lodged on the premise that the texts used in educational media and instructional technology courses for preservice teachers have been and continue to be strongly influenced by general ISD theories which have Gagne's theories embedded in them, it is recommended that the reader examine these texts and their potential in relationship to Gagne.[8]

Finally, teachers at the K-12 level, as well as those at the college and university level, have tremendous responsibility for instructional design albeit much less formal than professional designers might be accustomed to or prescribe. Therefore, the exposure to instructional design this group receives while participating in education courses utilizing the theories of Gagne and other theorists has the potential to significantly influence the course and unit design these practitioners engage in throughout their careers. The large number of pre-service teachers in the United States who take media and methods or instructional technology courses provides evidence for the potential impact of these teachers adapting Gagne's theories and models in their practice. Although, as mentioned earlier, the adapted instructional design practiced by teachers, instructors and professors is, on the surface, often less systematic and formalized than the instructional design models recommended in Gagne's books, nonetheless it does qualify as designing instruction. Instructional design theorists and researchers would be well advised to consider preservice teachers and their professors as one of the many types of instructional designers. In so doing the texts written for them might acknowledge organizational differences within which these professionals work and subsequently influences how they design

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[8]The flagship texts in terms of practical application to preservice education are the Heinich, Molenda, and Russell editions of Instructional Media and the New Technologies of Instruction (1982, 1985, 1989, 1993). The third edition of the Heinich et al. is the first to mention Gagne's theory explicitly as widely accepted and recommended for the design of instruction; however, there is also ample evidence of implicit use of his work in the first and second editions. This, and other books in this genre, target an audience of preservice teachers primarily at the undergraduate level; however, they are also used at the graduate level as introductory texts in teacher education and instructional media programs. Their goals focus on providing their audiences with information, techniques, utilization, ideas and examples related to instructional media and the use of technology in education. These texts have had influence not only by mentioning Gagne's theories (although that is significant), but also by the fact that the professors, instructors and trainers of these courses use these texts. As professionals they have had wide exposure to Gagne's theories through their education as well as teaching multiple courses utilizing his work. These books often apply and model Gagne's theories and writings at least in implicit ways, and sometimes explicitly. This is clearly the case in the third and fourth editions of Heinich et al. (1989, pp. 42 & 53) wherein they cite Gagne and Briggs (1988) and Gagne (1985). Furthermore, the instructional design model recommended in these texts, and especially in the third and fourth editions, has many elements of Gagne's theories and is similar to other Gagne instructional design models.

instruction. Furthermore, these texts might then incorporate only the most practical and useful aspects of design theory from researchers such as Gagne.

Summarizing, the influence of Gagne's theories on instructional design practice spans a gap from a reliance on behaviorism as a foundational theory to the eventual adoption of cognitivism as an underlying theory. Further, Gagne's overwhelming influence on the literature read by practitioners and the researchers who teach them has had significant impact on practice. Finally, the indirect or implicit influence Gagne has had on the informal instructional design practiced by teachers and many professors through texts for preservice education is greater than many writers realize.

Gagne's Influence on the Transfer of Learning

When reading Gagne's work, and especially the four editions of The Conditions of Learning, one is impressed with his attention to detail related to the many dimensions of learning and transfer. Gagne discusses often that learning should be generalized to new and varied content and applied to situations in the learners life. Syllogistically, the argument could be made that through the four editions of The Conditions of Learning, and through his work with the Events of Instruction, Gagne always had been, and continues to be, dedicated to both near and far transfer.

Gagne (1989) was experimenting with the transfer of training as early as the late 1940s. This early research examines positive and negative transfer and discusses transfer in the context of giving: ". . . different amounts of training to separate groups of subjects on an initial task which was a subordinate part of a total skill involving four differential manual reactions" (p. 22). This research was done with training subjects on complex motor tasks using multiple trials and observing them for periods of little or no improvement (plateaus) in learning. In this study the control group performed better than the group with too few trials (negative transfer). The control group was out-performed by the group having optimal trials (positive transfer). Positive and negative transfer are defined in many ways; the following eclectic definitions suit this discussion.

> Positive transfer occurs when learning one task assists in the performance of another; or when a previously learned task enhances the ability or performance in another task or control group.
> Negative transfer occurs when the learning of one task impairs the learning of another; or previously learned task is an impediment to performance; or experimental group is outperformed by the control group.

It is predictable that Gagne's view of transfer would parallel the previous definitions at that time in his career given the influence of early behaviorists like Pavlov, Guthrie, Tolman, Skinner and Thorndike on his work. Further, his work involving positive and negative transfer became the basis for his later concept of transfer which has been so thoroughly embedded in the practice of instructional design.

The discussion that follows is centered on Gagne's evolving concept of transfer over a 20 year span. During that time frame his use of the term was modified from one which differentiated between positive and negative transfer to the more contemporary lateral and vertical concepts found throughout the literature and utilized by practitioners today.

Gagne (1962) in later references to transfer builds on the concepts of positive and negative transfer. When discussing transfer in the context of ". . . transfer of training from component learning sets to a new activity which incorporates these previously acquired capabilities" (p. 364) he seems to be directing his focus more toward generalization, which becomes the focus of his later conceptualization and subsequent definition of transfer. Gagne (1965), when discussing external events and the conditions of learning indicates the need for what has been learned to be ". . . generalizable, and transferable . . ." (p. 206) to new and different situations where it might be applied.

Gagne (1970) says that capabilities learned in school should provide students with the background and skills to accomplish practical things in their lives or in occupations and identifies this as lateral transfer. Furthermore, he says students should be able to learn more complex things as a result of their previous learning. This learning of more advanced or complex tasks or skill based on subordinate rules or concepts is called vertical transfer. The defining of lateral and vertical transfer within the framework of the conditions for learning helped establish the foundation for applying the concept of transfer to contemporary instructional design practice.

Some of Gagne's lesser known theories of learning and instruction are both an indication of his continued search for unique ways of solving learning and instructional problems, and his willingness to examine the contrasting work of other researchers. Gagne (1968) offers the cumulative learning theory to those practitioners having some difficulty with total acceptance of his hierarchical or taxonomical theories. Although hierarchical in the pure sense, the cumulative learning theory offers a modified approach to learning and transfer. His explanation of this theory begins with his

contrasting two models of intellectual development, one by Hall and Gessell and another by Piaget. Gagne also examines two kinds of capability change, both of which are observable and distinguishable by the time frame required for the change to take place. Those changes in behavior capabilities that occur in hours, days, or weeks are referred to as learning and memory; those behavior capability changes requiring months or even years are called development. One of the many questions surrounding the difference between learning and development is that each view transfer of learning from a different perspective.

Additional examination of Gagne's theories related to human development reveals his Cumulative Learning Model and its relationship to transfer. Gagne maintains that using this model, which begins with S-R connections, and proceeds through concepts and simple rules and culminates with complex rules, will enhance transfer. In other words, learned capabilities at any stage of the model will not only transfer to further enhance the intended learning (i.e., the content for which the hierarchy was originally designed), but may also serve to transfer to new but related tasks. Gagne (1988), when referring to "stages" or "levels" in reference to learning new material related to previously learned material, states:

> Cumulative learning thus assumes a built in capacity for transfer. Transfer occurs because of the occurrence of specific identical (or highly similar) elements within developmental sequences. (p. 338)

Gagne, adds that "elements" has specific meaning in this discussion of transfer since it refers directly to ". . . rules, concepts, or any of the other learned capabilities . . ." (p. 338).

However, the larger question here is: do instructional designers, engaged in the process of practicing their skills and selecting learning theories automatically consider cumulative learning as a theory? The author's bias leads him to the conclusion that a large percentage of practitioners are not familiar with it much less utilize it in their practice to enhance transfer. Designers familiar with theories which are not "mainstream" whether Gagne's or others face the dilemma of: going back to what they know best, or experimenting with fresh approaches at a time when deadlines are shorter, and there is increasing pressure to decrease the time of the design cycle.

When considering Gagne's transfer theories and their relationship to intellectual skills and higher order capabilities, it is evident that Gagne accepts the proposition that intellectual skills and higher order capabilities may be learned for a specific intent or objective. These then become the background for generalization or transfer to other or new learning. The generalizations made by the learners may be a result of planned instruction, while in other cases they may (based on need or curiosity) take the initiative to learn independently. Since learning ascribed to this theory is cumulative, it often becomes more complex in the process of development; therefore, generalization and transfer between and among those things already learned and/or those to be learned is enhanced. Gagne (1988) when commenting on the process of transfer says: "There is no magic key to this structure--it is simply developed piece by piece. The magic is in learning and memory and transfer" (p. 332).

Summarizing the preceding definitions and discussions of transfer and their implications, Gagne's perspective is clear: the most important aspect of transfer is its dependency on what has already been learned. In short, there is nothing to transfer if it hasn't already been learned. The second criteria, and equally important to transfer, is the necessity to vary the situations and possibilities in the environment that the learner is expected to generalize the learning.

The concepts of far and near transfer have significant ramifications for instructional design practitioners since the design process is grounded in the application of learning both immediately after education or training or in the future as learners continue their education or employment. Far and near transfer are similar to Gagne's definition of lateral and vertical transfer, their similarity can be found through examining the functions of time, learning of subordinate skills and content complexity. Near transfer is concerned with application of instruction similar in complexity to the immediate future, where far transfer has the expectation of generalizing or applying learning over a longer time frame, and often in varying situations and contexts to the original training. A similarity between near and lateral transfer can be found in their expectation of applying concepts and procedures to problems or situations equal in complexity to those practiced in the instruction. Moreover, both vertical and far transfer have the expectation that the learner apply their learning over time and to new concepts and problems often to those more complex and unlike those presented and practiced in the original instruction. This brings the discussion to the internal dimension of both vertical and far transfer. Vertical and far transfer rely on the learner having mastery of a variety of knowledge, information and skills which in turn enhances the possibility of transfer occurring. The practicing instructional designer, through their design of the instruction, should build in a positive environment for learning. This environment should not only allow, but also strongly encourage, learners to experience "real life" situations in their instruction and to rehearse their perceptions of the concepts and information with other learners while they are being taught.

Although most researchers and theorists in the domains of instructional design, educational psychology and education support the concept of transfer, there are those who question the underpinnings of the transfer theories posited by Gagne and others of like mind. Singley and Anderson (1989) have written an entire book addressing transfer from the perspective of enhancing the probability of it occurring in the area of cognitive skills. Although they have devoted considerable effort to their investigation of transfer, Singley and Anderson question some of the premises related to vertical transfer and the effectiveness of hierarchical analysis and the identification of prerequisite skills as a method for enhancing transfer in curriculum design. They don't rule out the possibility of the success of this method; however, they question the effectiveness of it and recommend more specific research in this area.

Application of Gagne's transfer theories to contemporary instructional design practice are many, but few are any clearer than Dick and Carey's (1990) discussion of goal analysis and subordinate skills analysis. They suggest that designers can easily be misled by focusing on what learners need to know rather than what the learner must do. Furthermore, they insist that when analyzing subskills, the designer must ask what is it that the student must already know how to do, the absence of which would make it impossible to learn this subordinate skill? The utilization of this rhetorical question to illustrate a point related to transfer of learning, is a clear indication of the impact of Gagne's work these authors and subsequently on instructional design practice given that it is found in what was described earlier as a high profile and widely used practitioner text.

Summary and Conclusions

Attention here will be directed toward bringing closure to the discussion of the lasting influence Gagne's theories have had on practice. Further discussion of salient research, theories and practice presented in the paper will be included.

Perhaps the best place to start is with Gagne (1989) himself. In the Preface to Studies of Learning: 50 Years of Research, Gagne says:

> Learning theory has maintained its interest for me over many years. However, the questions addressed in my research have usually been practical ones, or at least have been strongly influenced by practical considerations. (p. 6)

This statement and others made in the preface of his book reflect Gagne's perception of his efforts to use research and theory to solve practical problems. As Gagne nears the end of the preface, in what appears to be an introspective comment about life choices, says: "My move to Florida State in 1969 was the beginning of a concentrated effort devoted to teaching and writing in the field of instructional design" (p. 6). Gagne seems to be acknowledging here that his intention was to link his vast research and theory base in instruction and learning with learners and the profession through teaching and writing.

Gagne's perception of his life's vision seems to be one of research and writing which initially focused on learning, and eventually, moved toward important contributions to theory. Gagne has, through his unwavering examination of the practice of instruction and applying it to how human beings learn, contributed greatly to the building of a foundation for the field of instructional design. Clearly his interest in learning in schools, as related to curriculum, and the examples he used to illustrate his theories are evidence of his interest in applying his theories to practice. His evolution from experimental psychologist to an instructional and learning theorist, whose focus became one of application of cognitive theories to instructional design, is indicative of not only his flexibility, but also his interest in instructional design practice. His place in the history of instructional design practice is most certainly secure from both a foundational as well as an applicational perspective.

Concluding from the examination of Gagne's influence on curriculum it is clear that his work has been significant. Evidence of his influence can be found in the many applications of his theories and research to a wide variety of content areas, age levels and learning environments. Additionally, his theories have withstood the test of time having been applied to curriculum of various types over the course of 50 plus years. As mentioned earlier his influence on the curriculum of science has perhaps been most broad based, long lasting and nationally acclaimed.

Questions remain as to how Gagne's theories will endure in light of the many available and competing theories that practicing instructional designers, curriculum specialists and educators now have as options when designing instruction.

A partial answer might be found by revisiting an interview Gagne had with the editor of Educational Technology in 1982. The editor asked Gagne if he thought instructional design would eventually transition entirely from behaviorism to cognitive psychology or would there remain a behavioral presence. Gagne responded by saying:

> I think that designers who work with cognitive learning theory in mind really incorporate the important parts of behavioral theory. Therefore, I think the answer to your question must be "yes." I do believe that the cognitive approach will come to dominate, if it hasn't already. (p. 580)

Does Gagne's response, from 13 years ago, offer us any clues to lasting impact of his theories in light of the large theory base available in the mid-90s? The answer is: a qualified yes, since designers are often pragmatists in their everyday practice of instructional design. Subsequently, they will select those theories and elements of theories, that seem logical and have a high probability of working in the situations and environments they find themselves.

A final comment on Gagne's future influence on curriculum must take into account the writers, researchers and theorists in curriculum publications. These documents would lead one to conclude that constructivism will be the dominant force in curriculum construction in the nineties. Earlier, when discussing curriculum, it was noted that Gagne was cited only once in the 1991-94 ASCD Handbook while constructivism and situated cognition were cited often. Furthermore, the ASCD publications have generous citations, methods, and corresponding activities that are very situated or constructivist in nature.

Returning to Finiley's work may offer another perspective for the reader. Finiley's criticisms of Gagne in 1983, which were fundamentally philosophical, might have been harbingers to the late 1980s and early 1990s. One thing seems clear, if the differences between constructivist philosophy and the inductive empiricism of Gagne are perceived to be irreconcilable by a majority of the theorists, this may, eventually, decrease Gagne's influence on instructional design practice and curriculum construction. However, another scenario may be, that practitioners will utilize Gagne's theories more selectively.

The genesis of Gagne's theories found their way into my practice before I knew they existed or what they were, and 10 years before I heard the name Robert M. Gagne. I learned from the instruction, which I believe was designed using his theories, because it was logical, provided me with enough practice to reach mastery and subsequently be successful. I taught from the instructionally designed materials which utilized his theories because they were comprehensive, well planned and worked. I continue to utilize his theories, selectively, 25 years later, as a significant part of my practice for many of the same reasons. Gagne's theories will continue to evolve as scholars analyze his work in search for new meaning. Gagne has a lasting place in the future of instructional design and educational practice. His theories and positions will undoubtedly be reinterpreted, modified and expanded, but his prominence will remain.

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